Operating Manual
STXL Advanced Series
CCD Cameras

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DECLARATION OF CONFORMITY

We, Santa Barbara Instrument Group, a division of Aplegen, Inc., 150 Castilian Drive, Santa Barbara, CA 93117 USA, (805) 308-6985, declare under our sole responsibility that the Model STXL CCD camera complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Note: This equipment has been tested and found to comply with the limits for a Class B digital device pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses, and can radiate radio frequency energy and if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the receiver and the equipment.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

A ferrite clip on the USB cable and Guider HDMI cable must be used when operating this equipment.

You are also warned that any changes to this certified device will void your legal right to operate it.

Operating Manual for STXL Series Cameras
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1.0. CAMERA HARDWARE

Congratulations and thank you for buying one of Santa Barbara Instrument Group's STXL Series CCD cameras. These large format cameras are SBIG's ninth generation CCD cameras and represent the state of the art in CCD camera systems with their low noise and advanced capabilities. The STXL Series cameras include several exciting new features: self-guiding in front of the filters, enhanced cooling capabilities, both high speed USB 2.0 interface and Ethernet interface, plus other innovative features found nowhere else.

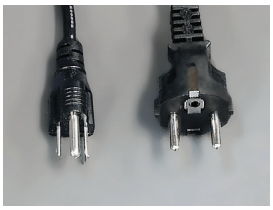
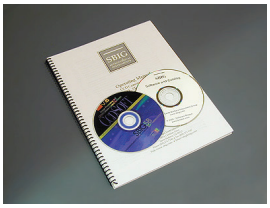
1.1. Introduction and Overview

These cameras can control two CCDs: The imaging CCD inside the sealed chamber, and an external tracking CCD located either in the self-guiding filter wheel or remote guide head. The new cooling design is capable of exceptional performance even in warm climates. The relay output plugs directly into most recent commercial telescope drives and is easily adaptable to virtually any drive system. As a result, you can take hour long guided exposures with ease, using either the built-in guiding CCD or the remote guiding head. Using the self-guiding filter wheel eliminates differential deflection of a guide scope relative to the main telescope and requires no radial guider setup. The remote guiding head allows for a convenient alternative if using camera lenses or when less backfocus is required. This dual tracking mode capability, coupled with the phenomenal sensitivity of the CCD, will allow the user to acquire observatory class images of deep sky images with modest apertures!

1.2. Unpacking the Camera

It is always a good idea to check over your new camera to make sure that you have received all necessary parts and standard accessories. Each STXLL Series camera is packed in a deluxe custom carrying case. This case contains all the items necessary to operate your camera. The case is sealed at the factory with a “plastic padlock” that cannot be removed without leaving evidence that the case was opened. If you received your camera without one of these plastic security locks sealing the case, please immediately take inventory of the contents and contact your dealer or SBIG to report the condition of the camera and accessories.

Standard Equipment for STXL Series Cameras:

STXL Camera	**Universal Power Supply**	 **Regional AC Cord and Plug**	**Power Cable Extension**
15' USB Cable	**Tracking Cable / Adapter**	 **Software and Manuals**	**Custom Pelican Case**

Standard Items:

Camera Body
The STXL Series Camera Body incorporates an imaging CCD, two-stage cooling, high-speed USB interface, Ethernet interface and opto-isolated relays for telescope control. An accessory plate with 3" threaded aperture is fixed to the front of the camera body for attaching to your telescope adapter. Due to the large size of some CCDs used in the STXL series cameras, a 2" nosepiece is too small to use without vignetting the image. Rack handles are also attached to the camera body at the factory. In addition to making the camera easier to handle in the dark, these handles also protect the fan housing when the camera is placed on a flat surface or when it is packed in its carrying case.

Universal Power Supply
The STXL's universal power supply enables operation of the camera from 100 to 240VAC, 50-60 Hz. Note that the power supply has a different pin configuration than the camera power port. The supplied extension power cable must be used between the power supply and the camera. This extension cable provides the correct pinout for the camera. Use only the power supply provided with the STXL camera. The earlier model STL cameras also have a 6 pin power port, however the power supplies provided with STL cameras do not provide sufficient current to operate the STXL series cameras.

Power Supply Extension Cable
This cable extends the distance the power supply may be placed away from the camera. It is also much more flexible than the short lead provided with the power supply. Finally, the extension cable adapts the four-pin output of the power supply to the six-pin DIN plug at the camera.

Regional AC Cord and Plug
AC cords with either European or North American style plugs are provided.

15' USB Cable
A standard 15' USB cable is supplied

Relay Cable
The tracking cable is a 6 conductor flat cable with 6 pin modular telephone style plugs at both ends

Software and Manuals
A complete package of camera control software, drivers for both 32 bit and 64 bit Windows O/S and manuals are included.

Custom Pelican Case
The Pelican brand carrying cases provided for the STXL Series cameras are high quality, waterproof, dustproof, crushproof cases that carry a lifetime guarantee from the manufacturer.

Optional Items:

Filter Wheels
SBIG offers two filter wheels for the STXL series cameras. The FW8S-STXL is a standard filter wheel with 8 positions for 50mm round un-mounted filters. The FW8G-STXL is identical except that it incorporates a self-guiding CCD in the filter wheel cover, in front of the filters.

Custom Filters
50mm round filters are commonly available from several manufacturers. As of this writing, SBIG offers filter sets from Baader Planetarium and Astrodon. Sets designated as LRGBC contain both a Luminance and a Clear filter in addition to the RGB filters. Some manufacturers provide a Clear only and some provide a Luminance only. A Luminance filter is both UV and IR blocked. A clear filter is not blocked, but should be AR coated.

Remote Guide Head
The optional STXL Remote Guide Head contains a KAI-340S CCD identical to the guiding CCD that is built into the Self-Guiding Filter Wheel. This remote head allows you to use a separate guide scope or off-axis guider to place the guiding CCD outside the

filter wheel for convenience when imaging through narrow band filters or anytime you wish to use an external guider.

Canon EOS Lens Adapter
This adapter allows the use of Canon EOS camera lenses on STXL cameras equipped with the standard filter wheel.

12VDC Power Cord
A 12VDC power cord is available for field operation directly from a battery.

12V Water Pump
A submersible pump is available for water cooling. It is only necessary to provide a constant flow of water through the heat exchanger to achieve maximum cooling. Cooling the water supply is generally not necessary but may be used for additional cooling if desired. If you do not have a ready source of water this pump will work in the field from 12VDC.

1.3. Parts and Assembly

The front section of the camera body contains the CCD chamber, shutter, electronics, and desiccant plug. The rear section contains the heat exchanger, fan, power supply for 12VDC operation in the field, and fuse. The red front cover has a round black mounting plate with 3 inch threads and dovetail shape. The front cover may be removed from the camera body without exposing the CCD chamber to the air. The accessory plate is shimmed at the factory to provide a flat mounting surface that is parallel to the CCD. Under normal use, it should not be removed. If it is removed, please note the location of the shims around the screws holding the plate to the front cover so that they may be replaced in the same configuration. The rear cover has rack handles, fan and heat sink, plus ventilation slots for air circulation which should not be blocked or covered. Two water circulation fittings are found on the side of the camera opposite the power and other electrical connections.

1.4. Connectors

Remote Guide Head Port
This miniature connector is for attaching an optional remote guiding head or the FW8G-STXL Self-Guiding filter wheel guiding CCD. Both the remote guiding head and the FW8G-STXL contain a 16-bit, low-noise, KAI-340S guiding CCD identical to the guiding CCD built-in the camera. They draw power from the main camera and are controlled by the same software that controls the internal guider. This option allows the use of either the RGH or FW8G-STXL for self-guiding during long exposures. Each of these accessories have mechanical shutters and are therefore capable of automatically taking dark frames for the guiding CCD.

Power

This port accepts 12-14VDC in to power the camera and any accessories that may be connected to the I2C port. Use the supplied 100-240VAC Universal power supply or connect directly to a 12VDC supply such as a car battery. **If using the Universal power supply, note that the supplied extension cord must also be used between the power supply and the camera to provide the correct pin configuration at the camera. Note also, that the STXL's power connector will accept a direct connection from an STL camera power supply. If you inadvertently plug an STL power upply into an STXL camera, it will not cause damage to the STXL camera, but the camera will not**

operate reliably under full cooling power as the STL supply does not provide the required current for the STXL camera. If you wish to make a custom power cable, the pin outs for the connector may be found in the appendix of this manual. We recommend 16 gauge conductor for 10' to 15' of cable or 18 gauge conductor for less than 10' of cable.

Ethernet

This port is for controlling the camera using Ethernet instead of USB. Connect CAT5 Ethernet cable between this port and your computer's Ethernet port. See the Software Section 2.3 for instructions of using an Ethernet interface.

I2C-AUX Port

This port is for attachment of accessories: SBIG filter wheels, Adaptive Optics, etc. Accessories designed to use this port do not require separate power supplies or control cables running to the computer.

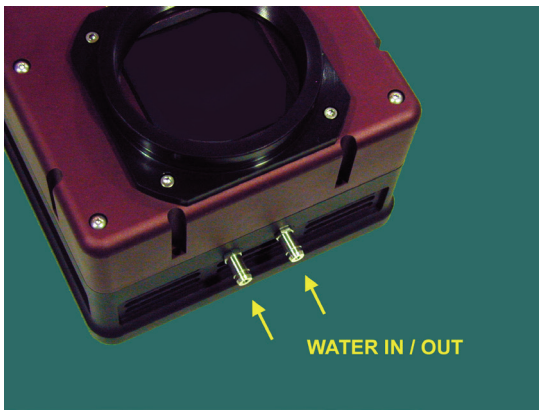
USB Port

Connect to your computer using a standard 15' USB cable. If your computer must be more than 15' from the camera we recommend an active extension for short distances (15' additional) or a powered USB extended such as the Icron Ranger for longer distances. The Icron Ranger allows USB devices to operate up to 100 meters from the host computer. For long runs we recommend using the Ethernet interface with CAT5 cable.

SCOPE Port

This port supplies the relay outputs for controlling the guiding of your telescope. Connect the supplied 6-conductor telephone style cable to this connector and the other end of the cable to your telescope drive's autoguider input port. See Section 1.6 for more information.

Water In / Out



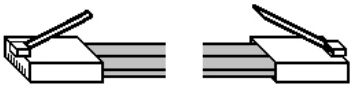
The camera can be operated with or without water circulation. Simply by attaching water circulation you can maintain a lower operating temperature in warm environments. The water circulation helps lower the temperature of the heat exchanger located in the back of the camera and this, in turn, makes it easier for the TE cooler to reach lower temperatures. The water does not need to be cooled, but it may be for additional efficiency. An optional 12VDC water pump is available from SBIG. The water fittings of the STXL cameras accept tubing with 1/4 inch inside diameter.

1.5. Attaching the camera to a telescope.

Due to the size of the largest CCD supported by the STXL camera, typical t-threads and even a 2" nosepiece will cause vignetting of the CCD. The accessory plate on the front cover of the camera has a 3" threaded aperture (3.00-24 UN-2B). The outside diameter of this threaded ring also allows for dovetail attachment with the appropriate sized adapter. Please check with your telescope manufacturer for an attachment adapter. Mechanical drawings are provided in the Appendix of this manual for making custom adapters.

1.6. Connecting the Relay Cable

The camera contains opto-isolated relays to control a telescope during self-guiding or when auto guiding. Most modern telescope drive controllers have a 6-pin modular phone style jack on their front panel or hand paddle for plugging in an autoguider. The relay outputs from the camera are brought out via a phone style connector labeled "SCOPE." To connect the telephone style Relay Cable to the camera, use the 6-conductor cable provided. Please note that the cable must have the connectors attached on each end in the correct orientation for autoguiding. See the diagram at right (Off-the-shelf cable for telephone use may have these plugs reversed).



CLIPS ARE ON SAME SIDE
OF CABLE AT BOTH ENDS

1.7. Attaching the Remote Head

The Remote Guiding Head is an optional accessory for all models of the STXL Series cameras. When attached to the main camera body, the Remote Guiding Head can perform all of the functions of the guiding CCD that is built into the camera. You control the Remote Guider using the same menu commands as you would for the internal guider. You can select which guider to use for a self-guided image. The Remote Guiding Head makes it possible to self-guide using a separate guide scope, or through an off-axis guider assembly that is placed in front of the filters. This can be useful when imaging through narrow band filters where stars are difficult to see. ***It is important to remember that you should not connect or disconnect the Remote Head to the camera while the power in on.*** It is a good idea, therefore, to plan your observing session in advance and connect the Remote Head at the beginning of the evening if there is any chance that you expect to use it that night. If you decide that you need the Remote Head in the middle of an observing session, it may be inconvenient to shut down the main camera and power back up again. The Remote Guiding Head contains a mechanical shutter and is therefore capable of taking dark frames without manual intervention by the user.

1.8. Connecting water hoses

STXL Series cameras are equipped with a heat exchanger that allows water circulation if conditions require additional cooling of the CCD. The cameras may be operated with or without water circulation. No special steps are necessary to use water circulation other than connection of a water supply. The camera comes with two water hose fittings (pictured in the inset at left) that accept a hose with an inside diameter of 1/4th inch. Very little water pressure is needed for additional cooling. Only enough pressure to maintain a constant flow is required to get maximum benefit from the water circulation. Also, it is usually not necessary to cool the water below ambient temperature with ice or refrigeration but it can be done so long as you monitor the dew point. Water at ambient temperature is an effective heat conductor and a constant flow of water will carry away enough heat from the heat exchanger that further cooling of the water supply will result in little gain. Cooling the water supply too much may cool the camera well below the dew point so that moisture forms on the inside surface of the case or the outside surface of the CCD chamber window. If you do not have a way to supply water to the camera, the 12VDC water pump and tubing shown above right is an optional accessory available from SBIG.

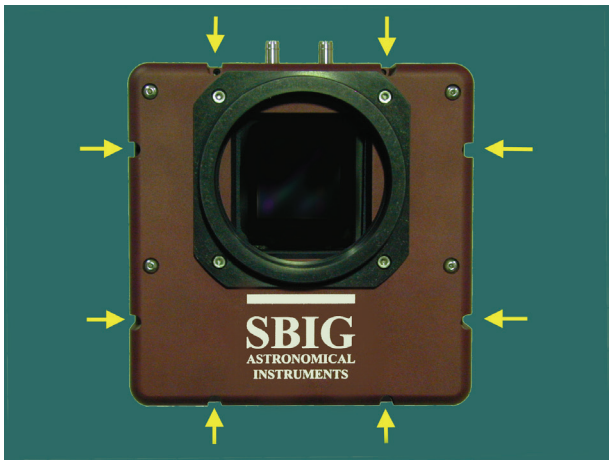
1.9. Extending the USB cable

The camera is supplied a standard 15' (~4.6 meter) USB cable. If you wish to operate the camera remotely, there are several ways to extend this distance between your computer and the camera:

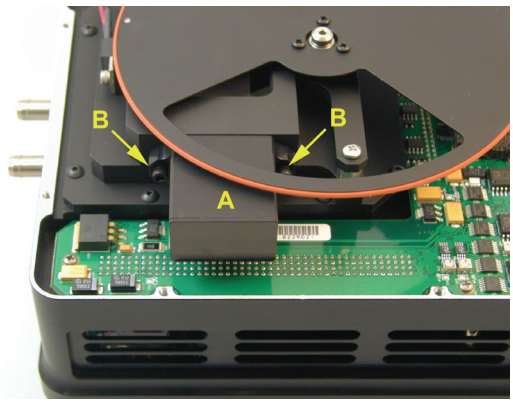
Active USB Extension Cable. These accessories are commonly available at computer stores and Radio Shack. They are 15 foot extension cables that get their power from the USB output port of your computer. These are good if your computer is located no more then about 30 feet (~9 meters) from the camera.

Powered USB extenders. Powered extenders such as the Icron Ranger (www.icron.com) are also commonly available in computer stores and by mail order over the Internet. These extenders require power at one end of the cable (either end) and will let you operate the camera (or any USB device) up to 100 meters from the computer.

1.10. Opening the Front Cover - Regenerating the Desiccant Plug

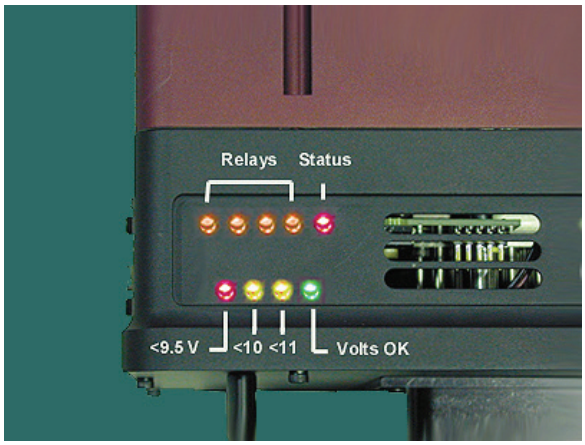


The CCD is housed in a sealed chamber located inside the front cover of the camera. The chamber is separate from the large front and rear cover plates, so that opening the front or rear cover plates will not expose the CCD chamber to the environment. The CCD chamber has a desiccant plug located on one side to help remove moisture from the air inside the chamber. If it should become necessary to recharge the desiccant due to excess moisture or frosting in the chamber, it is a simple matter to remove the desiccant plug, bake it in a conventional oven at 350 degrees F (175 degrees C) for 4 hours and replace the plug in the camera. To gain access to the desiccant plug, remove the front cover by loosening the eight socket head screws as shown in the picture above left. Note the location of the desiccant plug (A) in the next photo below right. Remove the plug by unscrewing the two socket head screws (B) holding it to the chamber. There is an o-ring between the plug and the chamber. Be sure to remove this o-ring before baking the plug. Place a small piece of electrical tape over the hole in the side of the CCD chamber while you are baking the desiccant plug to keep unwanted dust and moisture out of the chamber. When you replace the desiccant plug after baking it, remember to replace the o-ring.



1.12. Indicator Lights

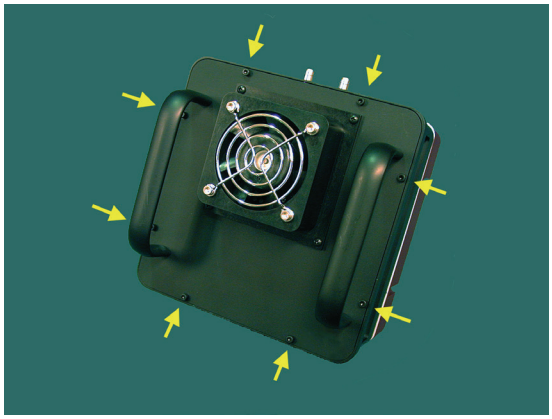
There are two sets of LED indicator lights located on the side of the camera body that provide information about the camera's communication link, exposure status, relay activity, and input voltage. The top row contains five LEDs: The red status LED will flicker when the camera is powered up. It will then either glow continuously when the camera is idle or blink when the camera is taking an exposure. The four amber LEDs indicate when any of the four relays are activated during during self-guiding. The bottom row contains four LEDs: These indicate the input voltage to the camera and are helpful when operating from battery power. Normally the Green LED will glow continuously to indicate that the power supplied is 12 -14 volts. The first yellow LED labeled 11V will light if the input voltage at the camera drops to 11.25V or less. The second yellow LED labeled 10V will light if the input

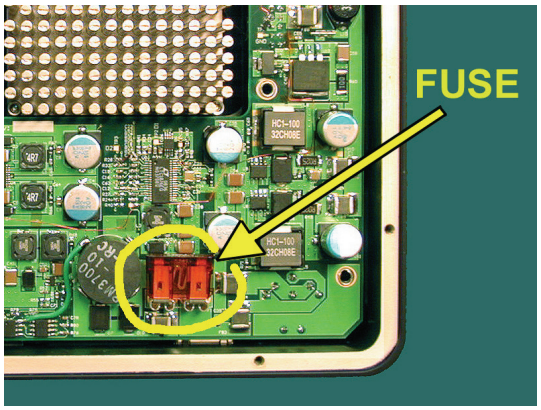


voltage at the camera drops to 10.25V or less. At 10.25V or less, the camera will automatically shut down the TE cooling but otherwise continue to operate normally. The final red LED labeled 9V will light if the input voltage at the camera drops to 9.25V or less. At this point the camera's operation may be unreliable and you should shut it down until the voltage can be brought back up to the normal operating range.

1.13. Opening the Back Cover - Changing the Fuse

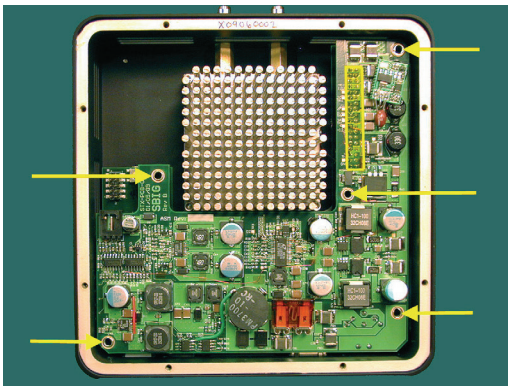
STXL cameras have a built-in voltage regulation that lets you run the camera directly from any unregulated 12VDC source such as car battery. The input to this supply is protected with a fuse





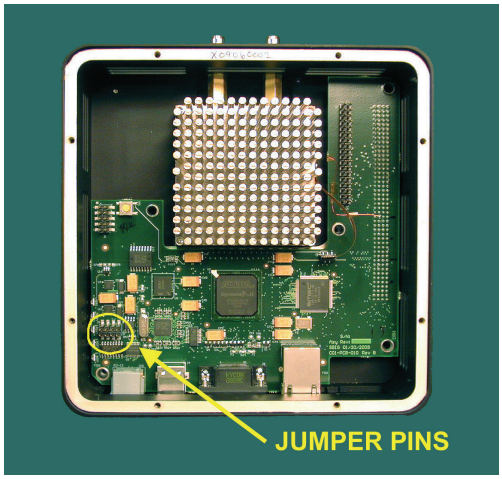
located inside the rear of the camera. To access the fuse, place the camera face down on a smooth clean surface. To help avoid any static damage, touch something metal that is grounded before opening the camera. Open the back cover plate of the camera by removing the eight socket head screws located around the perimeter of the back plate. Carefully lift the rear cover and turn it over. You will see a wiring harness for the fan that prevents the cover from being completely detached, but the wires should be long enough that the cover can be placed out of the way without unplugging the harness. The fuse is located on the digital board as shown in the right hand photo above. .

1.14. Using a Relay Adapter Box with the STXL

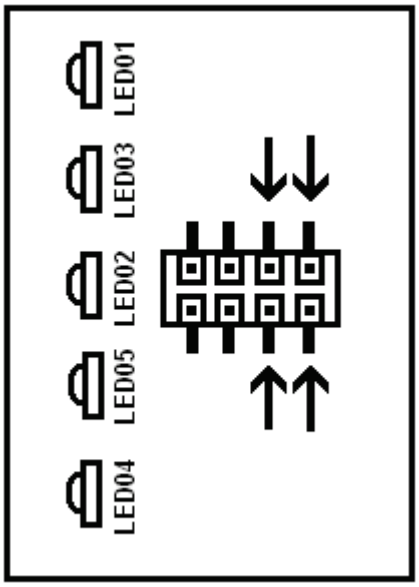


STXL cameras use opto-isolated relays that isolate the camera, electrically, from your mount's drive electronics. It is therefore unlikely that a Relay Adapter box will be needed with any commercial mount. However if you wish to use the Relay Box with mechanical relays for other reasons, then jumpers must be set inside the camera to provide 12V out on one pin of the SCOPE port. This is needed to supply power to the Relay Adapter Box before it can be used with the camera. To set the jumpers, remove the back cover of the camera as instructed in the previous section for changing the fuse. Unlike the fuse, however,

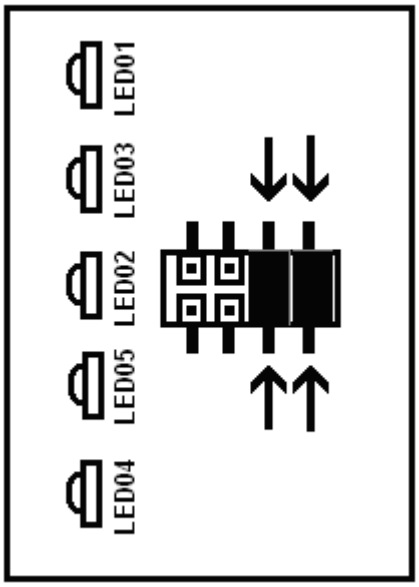
the jumpers are not on the top board, so it may be easier for this procedure to unplug the fan wiring harness from the digital board to get the wires out of the way. Then, remove the five long Phillips screws from the digital board as indicated by the arrows in the photo above. Note also the location of the rectangular box outline in the same photo. This outline indicates the location of a connector on the bottom of the digital board that attaches to the board below (visible in the next photo). To remove the digital board you must carefully pry this connector loose and lift the digital board away from the camera. Care should be taken not to pull too strongly on the digital board far from the connector as this could bend the board and cause cracks in the delicate traces.



Once the digital board is removed locate the jumper pins just next to the row of five LEDs that show through holes in the side of the camera body. The jumper pins are immediately adjacent to LED02 (see photo below). There are four pairs of pins. Jumpers must be placed on the two pairs of pins farthest away from the LEDs (bottom photo below).



Factory configuration: No jumpers.



Jumpers set for Relay Box

Replace the digital board taking care to align all the pins in the connector before applying slight pressure to seat the pins. Replace the five Phipllips-head screws and plug in the fan wiring harness. Then replace the back plate.

1.15. Camera Resolution

Resolution comes in two flavors these days. In the commercial world of digital devices, the word resolution is often used synonymously with the number of pixels used in a device. You are used to seeing ads for scanners with a "resolution" of 2,000 x 3,000 pixels, etc. Computer monitors have various "resolution" settings which are basically the number of pixels displayed. We use the word here in its literal sense, which is ability to resolve detail. This has nothing to do with the number of pixels, rather it is governed by the size of each pixel and the focal length of the optical system. Typically, seeing limits the resolution of a good system. Seeing is often measured in terms of the Full Width Half Maximum (FWHM) of a star image on a long exposure. That is, the size of a star's image in arcseconds when measured at half the maximum value for that star in an exposure of many seconds. As a general rule, one wants to sample such a star image with no less than 2 pixels. It is preferable to sample the star image with 3 or more pixels depending on the processing steps to be performed and the final display size desired. By way of example, if the atmosphere and optical system allow the smallest star images of 2.6 arcseconds in diameter (FWHM) then one needs a telescope focal length and pixel size that will let each pixel see 1/3 of 2.6 arcseconds. In this example the pixel field of view should be about 0.86 arcseconds per pixel for an optimum balance of extended object sensitivity to resolution of fine detail. If you aim for a pixel FOV of about 1 arcsecond per pixel through a given focal length, then you should be fine for the majority of typical sites and imaging requirements. If your seeing is much better than typical, then you should aim for less than one arcsecond per pixel. If your seeing is much worse than typical, then you can get away with 1.5 or even 2 arcseconds per pixel. The table above shows the field of view per pixel for several pixel sizes at various focal lengths. Select the focal length or range of focal lengths of your telescope(s) and look across for a pixel size that yields a field of view close to 1 arcsecond per pixel. Note also that the exception to this rule is planetary imaging where sensitivity is not an issue and resolution is paramount. In this case, aim for 0.5 or 0.25 arcseconds per pixel. Also

FL INCHES	Pixel Size in Microns										FL MM
	5.4	6.8	7.4	9	10.8	13.6	14.8	18	22.2	24	
10	4.38	5.52	6.01	7.31	8.77	11.02	12.09	14.62	18.03	19.49	250
20	2.19	2.76	3.00	3.65	4.38	5.51	6.05	7.31	9.01	9.74	510
40	1.10	1.38	1.50	1.83	2.19	2.75	3.02	3.65	4.51	4.87	1020
60	0.73	0.92	1.00	1.22	1.46	1.84	2.02	2.44	3.00	3.25	1520
80	0.55	0.69	0.75	0.91	1.10	1.38	1.51	1.83	2.25	2.44	2000
100	0.44	0.55	0.60	0.73	0.88	1.10	1.21	1.46	1.80	1.95	2500
120	0.37	0.46	0.50	0.61	0.73	0.92	1.01	1.22	1.50	1.62	3000
140	0.31	0.39	0.43	0.52	0.63	0.79	0.86	1.04	1.29	1.39	3600
160	0.27	0.35	0.38	0.46	0.55	0.69	0.76	0.91	1.13	1.22	4100
180	0.24	0.31	0.33	0.41	0.49	0.61	0.67	0.81	1.00	1.08	4600
200	0.22	0.28	0.30	0.37	0.44	0.55	0.60	0.73	0.90	0.97	5100
220	0.20	0.25	0.27	0.33	0.40	0.50	0.55	0.66	0.82	0.89	5600
240	0.18	0.23	0.25	0.30	0.37	0.46	0.50	0.61	0.75	0.81	6100
260	0.17	0.21	0.23	0.28	0.34	0.42	0.47	0.56	0.69	0.75	6600
280	0.16	0.20	0.21	0.26	0.31	0.39	0.43	0.52	0.64	0.70	7100
300	0.15	0.18	0.20	0.24	0.29	0.37	0.40	0.49	0.60	0.65	7600
320	0.14	0.17	0.19	0.23	0.27	0.34	0.38	0.46	0.56	0.61	8100
340	0.13	0.16	0.18	0.21	0.26	0.32	0.36	0.43	0.53	0.57	8600
360	0.12	0.15	0.17	0.20	0.24	0.31	0.34	0.41	0.50	0.54	9100
380	0.12	0.15	0.16	0.19	0.23	0.29	0.32	0.38	0.47	0.51	9700
400	0.11	0.14	0.15	0.18	0.22	0.28	0.30	0.37	0.45	0.49	10200
420	0.10	0.13	0.14	0.17	0.21	0.26	0.29	0.35	0.43	0.46	10700
440	0.10	0.13	0.14	0.17	0.20	0.25	0.27	0.33	0.41	0.44	11200
460	0.10	0.12	0.13	0.16	0.19	0.24	0.26	0.32	0.39	0.42	11700
480	0.09	0.12	0.13	0.15	0.18	0.23	0.25	0.30	0.38	0.41	12200
500	0.09	0.11	0.12	0.15	0.18	0.22	0.24	0.29	0.36	0.39	12700
520	0.08	0.11	0.12	0.14	0.17	0.21	0.23	0.28	0.35	0.37	13200
540	0.08	0.10	0.11	0.14	0.16	0.20	0.22	0.27	0.33	0.36	13700
560	0.08	0.10	0.11	0.13	0.16	0.20	0.22	0.26	0.32	0.35	14200
580	0.08	0.10	0.10	0.13	0.15	0.19	0.21	0.25	0.31	0.34	14700
600	0.07	0.09	0.10	0.12	0.15	0.18	0.20	0.24	0.30	0.32	15200

note that cameras with smaller pixels may be binned 2x2 or 3x3 to create larger pixels and expand the useful range of the camera. For example, an STXL-16000 with 7.4 micron pixels can be binned 2x2 to give 14.8 micron pixels. The overall field of view of the CCD does not change however, and a camera with larger pixels and a larger field of view might be preferable if it will not be used on shorter focal length instruments.

1.16. Camera Field of View

The field of view that your camera will see through a given telescope is determined by the focal length of the telescope and the physical size of the CCD chip. This also has nothing to do with the number of pixels. Through the same telescope, a CCD that has 512 x 512 pixels at 20 microns square will have exactly the same field of view as a CCD with 1024 x 1024 pixels at 10 microns square even though the latter has four times as many pixels. One can vary the focal length to vary the field of view. Using a focal reducer to shorten the focal length will increase the field of view (and make the image brighter in the process). Using a barlow or eyepiece projection to effectively lengthen the focal length of the telescope will decrease the field of view (and make the image dimmer in the process). In order to determine the field of view for a given CCD, note the CCD's length and width dimensions in millimeters (from the camera specifications) and use the following formula for determining the field of view for that CCD through any telescope:

Focal length in inches	APPROXIMATE DIAGONAL FIELD OF VIEW IN ARCMINUTES									Focal length in mm
	KAF-16803 KAF-9000	KAI-16000 KAI-11002	KAF-1001E	KAF-6303	KAF-8300	KAI-4022	KAF-3200	KAF-1603	KAI-2020	
1	7049	5886	4708	4478	3044	2895	2423	2239	2002	25
2	3525	2943	2354	2239	1522	1448	1212	1120	1001	50
5	1410	1177	942	896	609	579	485	448	400	125
10	705	589	471	448	304	290	242	224	200	250
20	352	294	235	224	152	145	121	112	100	500
40	176	147	118	112	76	72	61	56	50	1000
60	117	98	78	75	51	48	40	37	33	1500
80	88	74	59	56	38	36	30	28	25	2000
100	70	59	47	45	30	29	24	22	20	2500
120	59	49	39	37	25	24	20	19	17	3000
140	50	42	34	32	22	21	17	16	14	3600
160	44	37	29	28	19	18	15	14	13	4100
180	39	33	26	25	17	16	13	12	11	4600
200	35	29	24	22	15	14	12	11	10	5100
220	32	27	21	20	14	13	11	10	9	5600
240	29	25	20	19	13	12	10	9	8	6100
260	27	23	18	17	12	11	9	9	8	6600
280	25	21	17	16	11	10	9	8	7	7100
300	23	20	16	15	10	10	8	7	7	7600
320	22	18	15	14	10	9	8	7	6	8100
340	21	17	14	13	9	9	7	7	6	8600
360	20	16	13	12	8	8	7	6	6	9100
380	19	15	12	12	8	8	6	6	5	9700
400	18	15	12	11	8	7	6	6	5	10200

Object	Approximate Angular Size
NGC7000. N. American Nebula	175 x 110 arcmin
M31. Andromeda Galaxy	190 x 60 arcmin
M42. Orion Nebula	85 x 60 arcmin
Disk. Sun / Moon	30 x 30 arcmin
M101. Face on spiral galaxy	22 x 22 arcmin
M13. Globular Cluster	6.6 x 6.6 arcmin
M104. Sombrero Galaxy	9 x 4 arcmin
M27. Dumbbell Nebula	8 x 5.7 arcmin
M57. Ring Nebula	1.4 x 1 arcmin
Jupiter	40 arcseconds

(135.3 x D) / L = Field of View in arcminutes

where **D** is the length or width dimension of the CCD in millimeters, and **L** is the focal length of your telescope in inches. So, for example, if you wanted to know the field of view of the new STL-4020M camera when attached to a 5" F/6 telescope you would first determine the focal length of the telescope by multiplying its aperture, 5 inches, by its focal ratio, 6, to get its focal length, 30 inches. The CCD dimensions are 15.2 x 15.2 mm. To calculate the field of view multiply 135.3 x 15.2 = 2,057 and then divide by 30 = 68.6 arcminutes. By way of comparison, the field of view of the STXL-16803 through the same telescope would be 135.3 x

36.8 = 4,979 divided by 30 = 166 arcminutes. The table above shows the calculated field of view in arcminutes for each of the several large format CCDs at various focal lengths. Keep in mind however that when you vary the CCD field of view you are also varying the field of view for each pixel and are therefore also affecting the resolution of your system.

1.17. Focal Length, Resolution and Field of View

From the forgoing we see that neither resolution alone, nor field of view alone, are dependent solely on the number of pixels of a sensor. So when are more pixels better? The key word in the first sentence is "alone." All else being equal, more pixels will yield a larger field of view compared to another camera with fewer pixels of the same pixel size. The resolution will be the same through any optical system, because the size of each pixel remains the same. But more pixels mean a larger CCD and therefore a larger field of view ***at the same resolution***. So the question becomes: What is the field of view of a CCD at a given resolution based upon pixel size and the focal length of your optical system?

The tables on the preceding pages can help you determine this answer. The table below uses the KAF-16803 CCD as an example:

KAF-16803 with 4096 x 4096 pixels at 9 microns

FL INCHES	Pixel FOV (arcseconds)	CCD Diag. FOV (arcminutes)	FL MM
10	7.31	705	250
20	3.65	353	510
40	1.83	176	1020
60	1.22	118	1520
80	0.91	88	2000
100	0.73	71	2500
120	0.61	59	3000
140	0.52	50	3600
160	0.46	44	4100
180	0.41	39	4600
200	0.37	35	5100
220	0.33	32	5600
240	0.30	29	6100
260	0.28	27	6600
280	0.26	25	7100
300	0.24	24	7600

2.0. CAMERA SOFTWARE

This section gets you up and running right away with your STXL camera. First you'll install the Application Software and Drivers, then you'll have Windows Link the Drivers to the Camera and finally you'll connect to the Camera and take a few sample images. Please follow these instructions in order and ***do not attach your Camera to your Computer until instructed***.

Note: *The STXL Drivers require Windows 2000, Windows XP, Windows Vista or Windows 7 (or later). They will not work under older Windows versions like Windows 98.*

2.1 Installing Software

Before you can use your camera you'll have to install the **CCDOps** Application software and the Windows **Drivers** for the camera. We'll walk you through that in this section.

Installing CCDOps

SBIG's Application Software for our cameras is called **CCDOps**. It gives you full control of your camera's features. To install **CCDOps** follow the instructions below:

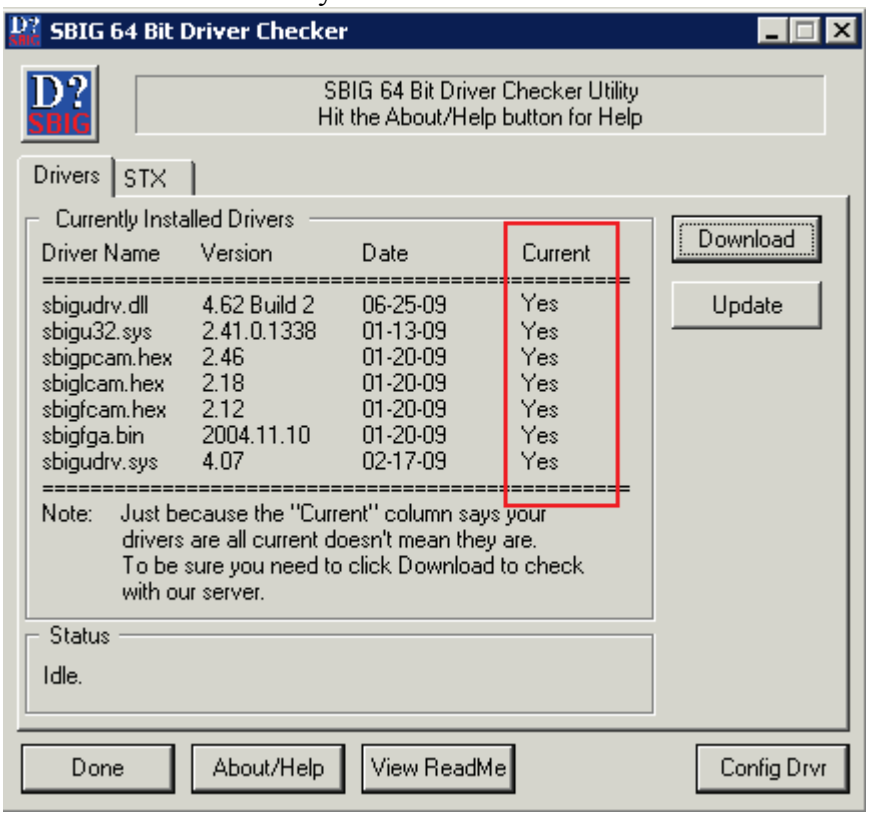
- Insert the CD-ROM that came with your camera into your computer's CD drive. If the CD doesn't auto-run Explore the CD and run the **autorun.exe** file in the root directory.
- Click the **Setup New ST Camera** button.
- Click on the **Install CCDOps** button and follow the onscreen instructions.

Installing the SBIG Drivers

SBIG Cameras require **Drivers** to be installed in Windows before you can communicate with them. Our **Driver Checker** program downloads the latest **Drivers** from our website and Installs them on your computer. Follow the instructions below to install the SBIG Drivers for your camera:

- Going back to the SBIG CD ROM program, click on the **Install 64-Bit Driver Checker**. You must use the 64-Bit Driver Checker with the STXL and it works on both 32 and 64 bit versions of Windows.
- Follow the onscreen instructions to install the **Driver Checker**. At the end of the Install opt to ***Launch the SBIG Driver Checker***.
- The **Driver Checker** will ask you about any older ST Series Camera you may have with or without the Remote Guide Head capability. Read the options carefully, select the appropriate setting then click **OK**. Click on the **Update** button to Install the Drivers.. In the process of installing the drivers it will show you a **ReadMe** file with notes about the current drivers and it will ask you to verify that you want to apply the Update. After clicking **Update Me** it will install the drivers on your system.
- Before you quit the **Driver Checker** you should see that all the Drivers are listed as *Current* in the table as shown below. If not click on the **Download** button to

Download the latest Drivers from our web site then click the **Update** button a 2nd time. Your versions may be different than those shown.


SBIG 64 Bit Driver Checker
SBIG 64 Bit Driver Checker Utility
Hit the About/Help button for Help
Drivers
STX
Currently Installed Drivers
Driver Name Version Date Current
sbigudrv.dll 4.62 Build 2 06-25-09 Yes
sbigu32.sys 2.41.0.1338 01-13-09 Yes
sbigpcam.hex 2.46 01-20-09 Yes
sbiglcam.hex 2.18 01-20-09 Yes
sbigfcam.hex 2.12 01-20-09 Yes
sbigfga.bin 2004.11.10 01-20-09 Yes
sbigudrv.sys 4.07 02-17-09 Yes
Note: Just because the "Current" column says your drivers are all current doesn't mean they are. To be sure you need to click Download to check with our server.
Download
Update
Status
Idle.
Done
About/Help
View ReadMe
Config Drvr

Linking the Drivers

Once the Camera Drivers have been installed they need to be linked to the camera by Windows. Follow the instructions below to link your Drivers to the Camera.

- *First off, Windows can be finicky when it comes to linking the drivers.* If you have any questions or problems with this procedure go back to the CD-ROM and read the **Application Note** which is available through a button where you Installed the Driver Checker.
- Power up the camera. The **LEDs** on the side should blink momentarily and the **Fan** should come on. This indicates the camera has completed its internal power-on boot-up sequence.
- Connect the Camera to your computer with the supplied USB cable. Windows will detect the Camera and bring up the **Add New Hardware Wizard**.
- The Wizard will ask you if you want to check for updated drivers. Select ***No, not this time*** then click **Next**.
- The Wizard will ask how you want to install the software (link the drivers). Select ***Install the software automatically*** then click **Next**.
- Follow the onscreen instructions to complete linking the drivers to your camera. At this point you could open the **Device Manager** and verify that you should see an entry for the **SBIG Camera**.

2.2. Using the Camera

This section gives you a quick introduction to using your Camera with **CCDOps**. Further information can be found in the **CCDOps Manual** on the CD ROM.

Establishing a Link with CCDOps

In order to control your Camera, **CCDOps** you must first establish a communications link with the camera as described below:

- In the Windows **Start** menu navigate to the **SBIG** folder then select the **CCDOps** icon to launch CCDOps.
- Under CCDOps' **Misc** menu select the **Graphics/Comm Setup** command.
- Check to make sure the **Interface** item is set for *USB* then click **OK**.
- Under the **Camera** menu select the **Establish COM Link** command.
- In a few seconds CCDOps will establish a link to the camera as indicated by the **Link** status field in the lower right hand corner of the CCDOps window:

Camera Setup

The **Setup** command in the **Camera** menu is used to configure the Camera's internal operating modes. As an example let's use it to turn on the cooling. Invoke the command and then set the **Temperature Regulation** item to *Active* and the **Setpoint** item to *0.0* then click **OK**. You'll see the Camera start to cool down as indicated in the **Temp** status field.

Taking Sample Dark Frames

Dark Frames are used in Astronomical CCD Imaging to reduce the noise of images by subtracting out fixed pattern noise inherent in the CCDs. Let's take a **Dark Frame** with the main or **Imaging CCD** to see what it looks like:

- Cover the camera so no light is getting into it through the Telescope Coupling. Cover the camera with a book or turn the camera over and place it on its face.

- Use the **Grab** command in the **Camera** menu. Set the **Exposure** to *1.0* and the **Dark frame** to *Only* then click **OK**. After several seconds the image will appear on the screen.

- In the **Contrast** window make sure **Auto** is *checked* and the **Mag** is set to *1:1*.

- Scrolling around in the image and inspecting it visually you'll notice how large it is (4096 x 4096 pixels) relative to your computer screen. You'll also see areas of "salt and pepper" that represent the noise floor or *Read Noise* of the CCD and

you'll see numerous bright or *Hot Pixels*. You'll probably see some *Hot Pixels* with *tails* below them. These are in every CCD camera and repeat from image to image. By subtracting **Dark Frames** from your images you'll remove these effects from the final image.

Let's try taking a **Dark Frame** with the **Tracking CCD** to see how it's different:

- In the **Camera Setup** command set the **Active CCD** to *Tracking*.
- Use the **Grab** command to take another **Dark Frame**.
- Visually inspect the image. First off you'll notice it's quite a bit smaller (640 x 480 pixels). In addition to the effects noted in the **Imaging CCD** you'll probably notice a general brightening from top to bottom. This is typical for interline CCDs like the **Tracking CCD** and again will repeat and subtract out of your final images.

Further Investigations

At this point we refer you to the **CCDOps Manual** on the CD ROM for further learning about getting the most out of your STXL CCD Camera. We also suggest you join the **SBIG Group** on Yahoo to learn from and interact with other users.

2.3. Specific Activities

This section describes some of the unique features of the STXL such as Ethernet control and Autoguiding.

Ethernet Configuration

The STXL allows communications to the PC with either USB or Ethernet. While USB offers faster image downloads Ethernet allows longer cable runs between the PC and the Camera, not being limited by the 15 foot USB cable length.

The STXL comes configured by the factory to have a fixed IP address of 192.168.0.100 but can be configured by **CCDOps** for other addresses or to use DHCP. Use the commands in the **STXL** sub-menu of the **Misc** Menu to configure the STXL.

To Establish a link over Ethernet with **CCDOps** use the **Graphics/Comm Setup** command in the **Misc** menu and set the **Interface** to *Ethernet* and either fill in the Camera's IP address or click the **Detect** button to search for it.

Web Browser

The STXL has an embedded web server built into it and can be controlled by your favorite Web Browser. This gives the STXL support on all systems with the minimum requirement of a Web Browser. The factory default URL of the STXL home page is:

http://192.168.0.100

If you've changed the Camera's IP address or are using DHCP the URL will be based on the assigned IP address.

Making the Autoguiding Connection

Like all SBIG cameras, the STXL has an Autoguider port that can be connected to your Telescope. Use the supplied 6-pin phone-jack based Autoguider Cable to connect the STXL to your Telescope.

2.4. Third Party Software

The STXL is compatible with many third party Astronomical Software packages. Several packages offer control of the STXL and many others offer Image Processing of FITS Format Images acquired with the STXL. This section describes several of those packages.

CCDSoft

Software Bisque in Colorado makes a popular suite of Astronomical Software including a Planetarium program called **TheSky** and an Imaging program that supports the STXL called **CCDSoft**. Information about these packages can be found at their web site. For STXL control please make sure you have the latest version.

www.bisque.com

MaximDl

Diffraction Limited in Ontario Canada has a popular Imaging program named **MaximDl** that works with the STXL. You'll need to be using Version 5 or later and make sure you have the latest SBIG Plug-In. Their web site is:

www.cyanogen.com

Support and Developer Resources

The SBIG web site contains a wealth of Software Updates, Manuals, Application Notes, Drawings and Developer Resources for the STXL and other SBIG products. We probably don't have to tell you but our web site is:

www.sbig.com

Appendix A – Adjustments and Maintenance
This section describes the various adjustments and maintenance issues with the STXL.

Firmware Updates
The STXL was designed to allow updating its **Firmware** (internal software) in the field. This is accomplished through the **STXL** tab of the **64-Bit Driver Checker** dialog. First you should **Download** and **Update** any driver changes through the **Drivers** tab and then switch to the **STXL** tab and apply upgrades there. The STXL uses the following types of **Firmware**:

Firmware Type	Purpose
USB	Firmware for the embedded USB processor.
Gate Array	Hardware definition and embedded firmware for the gate array and CPU.
ROP	Readout Programs for the 2 embedded CCD Readout Engines. These can be separate updates and are also embedded in the Gate Array file.

Internal Tracker Focus
The Imaging CCD in the STXL is large (~37 mm on a side) and hence the Tracking CCD is relatively far off axis. Many telescopes will show focus curvature off axis that can slightly defocus the Tracking CCD relative to the Imaging CCD. With the STXL minor corrections to the Tracking CCD focus position can be accomplished with a 3-32 inch hex-head screw adjustment behind the covered **TRACKER FOCUS** port above the Remote Guide Head connector.

Desiccant Regeneration
The STXL has an internal **Desiccant Plug** that keeps the CCD from frosting over at cold temperatures. The **Desiccant Plug** will typically go a year before requiring regeneration by baking the **Desiccant Plug** (***not the whole camera!***) in the oven. Remove the eight screws that hold the front cover onto the body of the STXL to get access to the **Desiccant Plug (see page 12)**

1. Remove the desiccant container from the side of the chamber according to the instructions on page 12 of this manual. Remove the O-ring.
2. Plug the resulting hole in the chamber by placing a piece of black plastic tape over the opening to keep dust out while you are baking the desiccant.
3. Heat the desiccant container in an oven at 350°F (175 deg C) for 4 hours. The solder used to seal the can melts at 460 degrees F, so be sure to stay at least 50 degrees below this number. Preheating the oven to avoid hot spots is advised.
4. Replace the desiccant container onto the CCD chamber, being careful to reinstall the O-ring and insure that it does not get pinched, and attach with the socket head screws you removed in step 1.

Expect the camera to take an hour or two to reach the frost free state. If it does seem to frost and

you need to capture images, reduce your cooling to the zero degree C range - the CCD dark current will still be quite low.

Cleaning the CCD and the Window

The design of SBIG cameras allows for cleaning of the CCD. The optical heads are not evacuated and are quite easy to open and clean. When opening the CCD chamber, one should be very careful not to damage the structures contained inside. To open the CCD Chamber, remove the six screws that hold the 5 inch front cover in place. Remove the six screws and lift the front cover, exposing the structures inside. There is a rubber O-Ring that sets in the groove on the top of the Chamber housing. The CCD array is protected by a thin cover glass that can be cleaned with Q-Tips and Isopropyl Alcohol. *Do not get alcohol on the shutter*. Dust on the CCD should be blown off. Use alcohol only if necessary. The optical window of the chamber housing can be cleaned the same way. When reinstalling the chamber housing, be very careful to make sure the O-ring is in the groove when seated.

Appendix B - Capturing a Good Flat Field

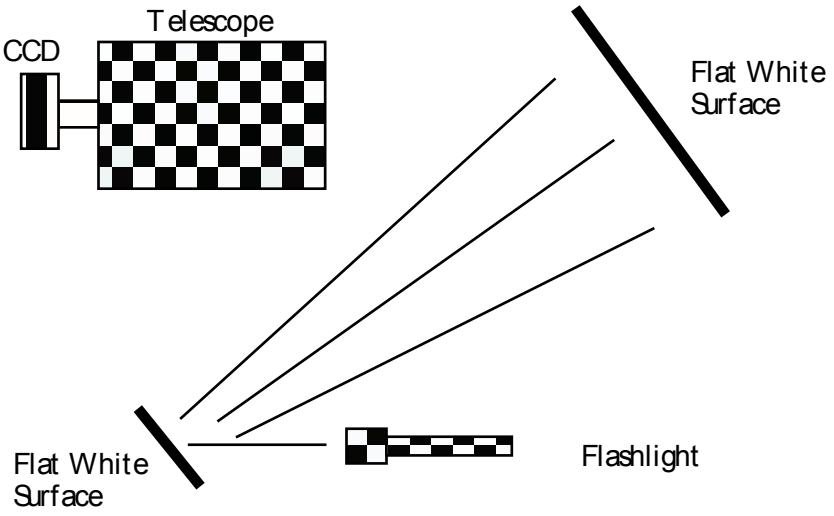
This appendix describes how to take a simple flat field. A good flat field is essential for displaying features little brighter than the sky background. The flat field corrects for pixel non-uniformity, vignetting, dust spots (affectionately called dust doughnuts), and stray light variations. If the flat field is not good it usually shows up as a variation in sky brightness from on side of the frame to the other.

B-1. Technique

The first consideration in capturing a flat field is to use the telescope-CCD combination in exactly the configuration used to collect the image. This means you probably have to capture the flat field at the telescope. Do not rotate the head between image and flat field, since the vignetting is usually slightly off center. Do not be tempted to build a little LED into the telescope or camera for doing flat fields; it doesn't work at all. The dust debris shadows would be different!

Arrange a light source such as a flashlight, two white cards, the telescope and CCD as shown in Figure D-1.

Figure D-1: Flat Field Geometry



The key aspects of this geometry are that the reflection off two diffuse surfaces is used, and the large flat surface is square to the illumination from the small flat surface. When we do this, the first flat surface is typically a white T-shirt worn by the operator! Take care that no apparent shadows are cast onto the larger flat white surface. Use an exposure at the camera that yields an average light level equal to about half of full scale.

Appendix C – Camera Specifications

All STXL Cameras have the following specifications:

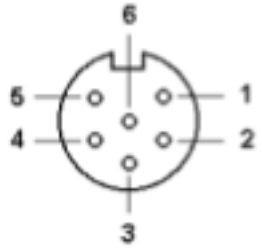
Power Requirements	
Input Voltage	10.5 – 14 Volts DC with Indicating LEDs
Current	8.5 Amps Maximum
Embedded Resources	
Processors	85 MHz, 32-Bit CPU with RTOS, Dedicated USB microcontroller
Frame Buffer	64 MB shared Frame Buffer and Processor RAM
Flash Memory	64 Mb Firmware and Parameter storage
External Ports	
Host Communications	USB 20/1.x and 10/100 Mbs Ethernet
Remote Guide Head Port	Compatible with Remote Guider-340
Autoguider Port	4 Open Collector Outputs with Indicating LEDs
Accessory Port	Powered I^2C for SBIG CFW, AO, etc.

Individual STXL models have specifications that are unique to the imaging CCD. Please refer to the camera model data sheet for specifications typical of your model.

Appendix D – Connector and Cables

Power Jack

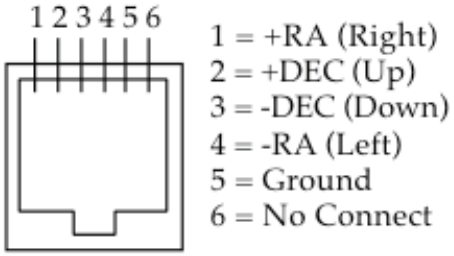
The Power Jack has the following pinouts:



Pin	Function
Shell	Earth/ Chassis Ground
1,5,6	+12V, 8.5A
2,3,4	DC Return

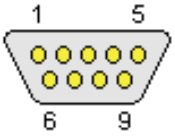
Scope Port

The Scope Port is used for autoguiding your telescope and has the following pinouts:



I2C/AUX Port

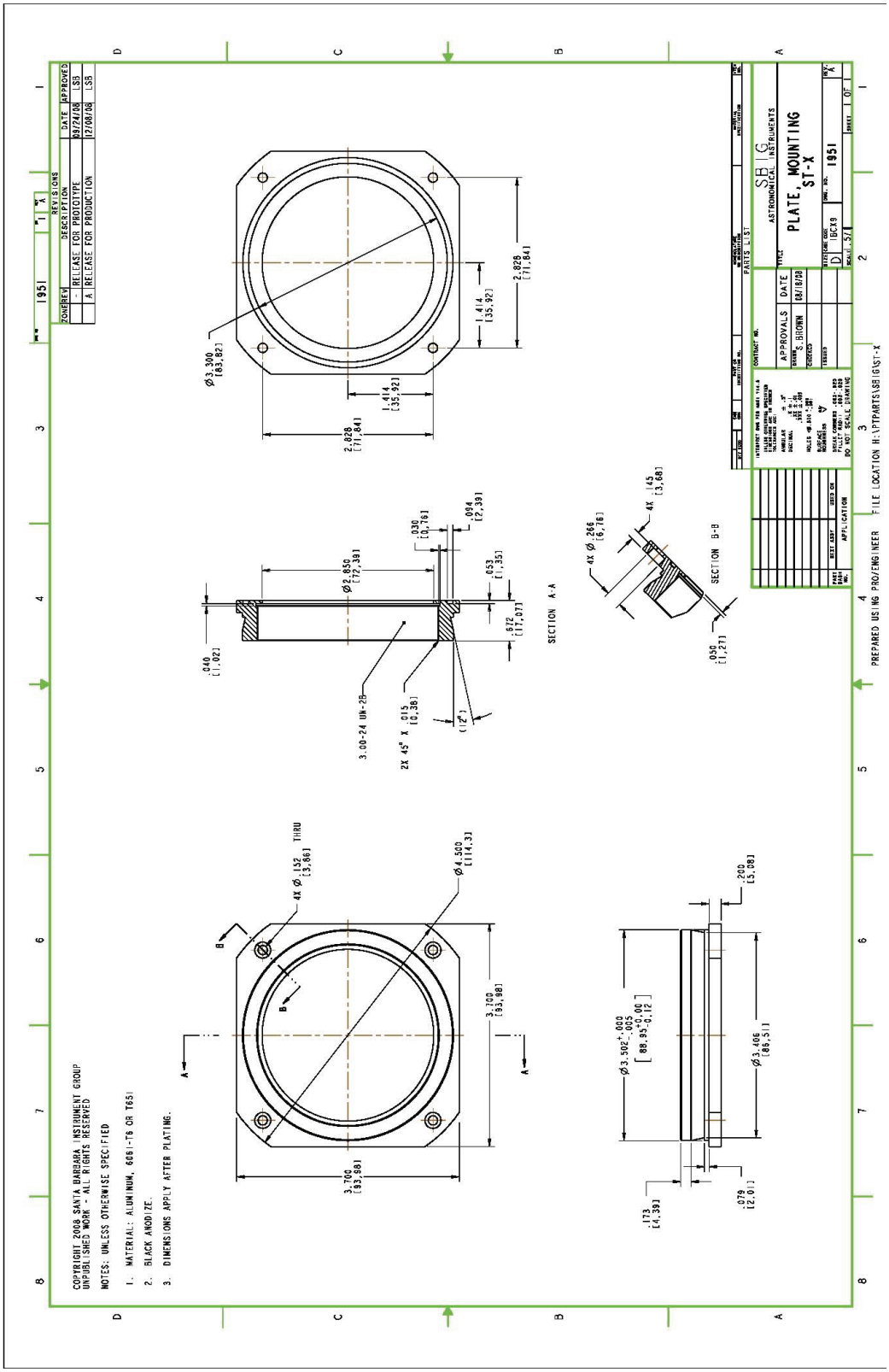
The I2C/ AUX Port is for connecting accessories to your STXL and has the following pinouts:



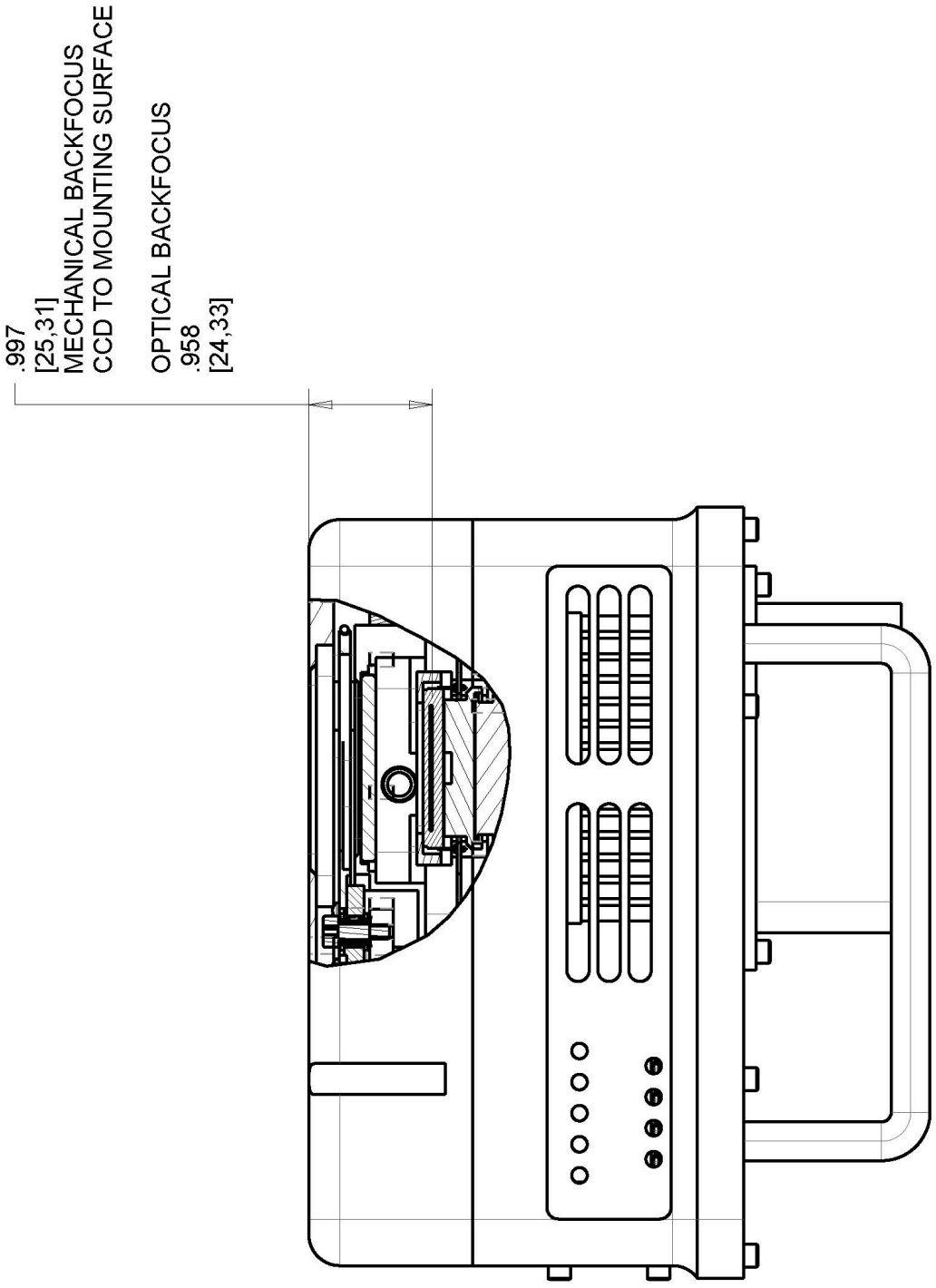
Pin	Function	Pin	Function
1	No connect	6	Trigger In
2	Open Collector Trigger Out	7	Open Collector Genl. Purp. Out
3	Serial Clock	8	+12V Raw
4	Serial Data	9	+3.3V
5	Signal Ground	Shell	Chassis Ground

Appendix E – Mechanical Drawings and Backfocus Distances

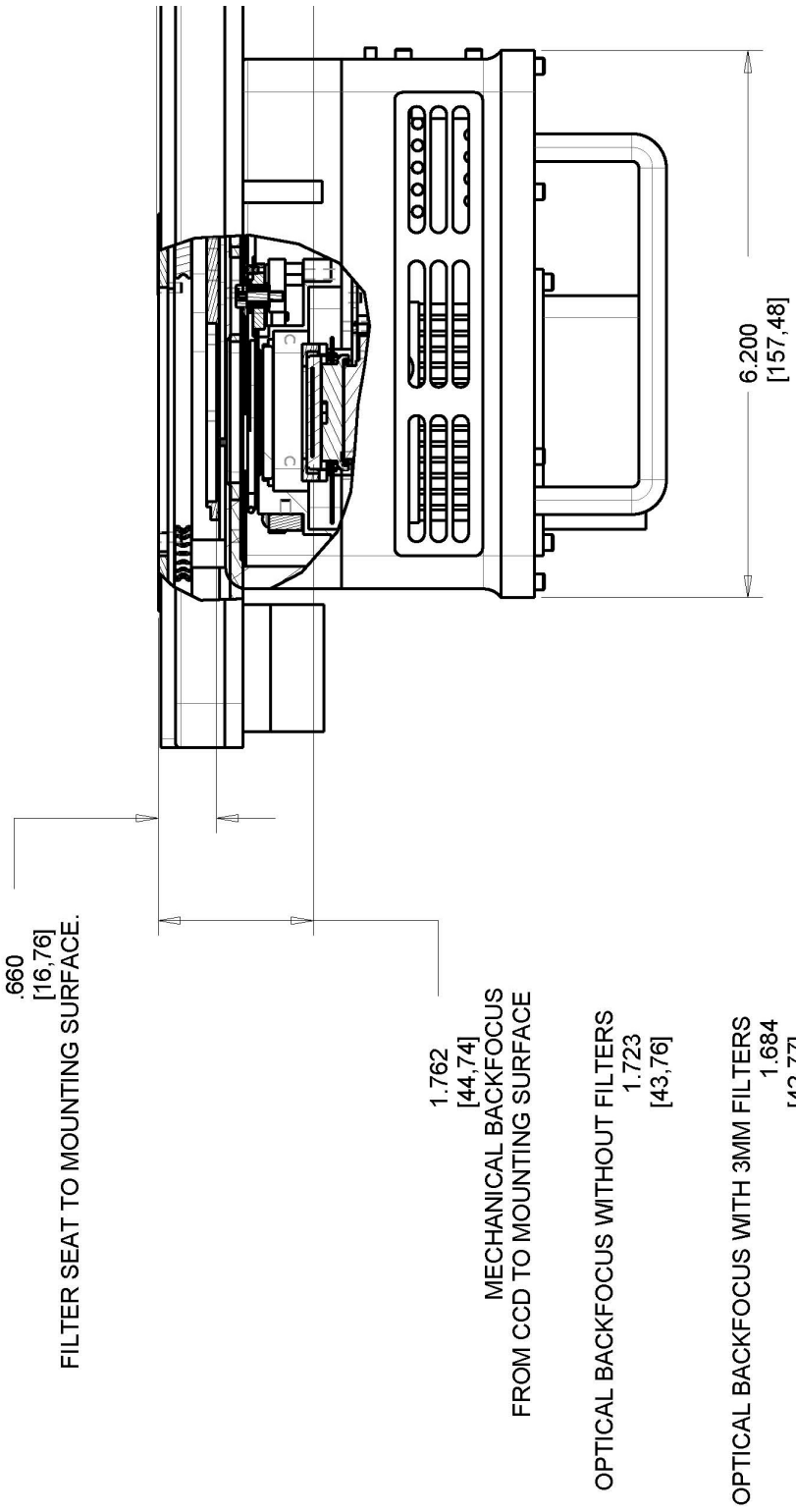
Adapter ring drawings and thread specifications



Backfocus: Camera without filter wheel.



Backfocus: Camera with Standard Filter Wheel.



Backfocus: Camera with Self-Guiding Filter Wheel